Forestry Research West

Forest Service
U.S. Department of Agriculture

February 1980

Forestry Research West

Forest Service
U.S. Department of Agriculture

February 1980

A report for land managers on recent developments in forestry research at the four western Experiment Stations of the Forest Service, U.S. Department of Agriculture

In This Issue

Cover

Researchers at the Intermountain Station have helped to develop a vegetation classification system for the grasslands and shrublands of western Montana. This new system should prove a big help in achieving multiple use planning and resource management on these lands. Read more about it on the facing page.

To Order Publications

Single copies of publications referred to in this magazine are available without charge from the issuing station unless another source is indicated. When requesting a publication, give author, title and number.

Each station compiles periodic lists of new publications. To get on the mailing list write to the Director at each station.

Subscriptions

Subscriptions to this magazine will be sent at no charge. Write To:

Forestry Research West
240 West Prospect Street
Fort Collins, Colorado 80526

To change address, notify the magazine as early as possible. Send mailing label from this magazine and new address. Don't forget to include your Zip Code.

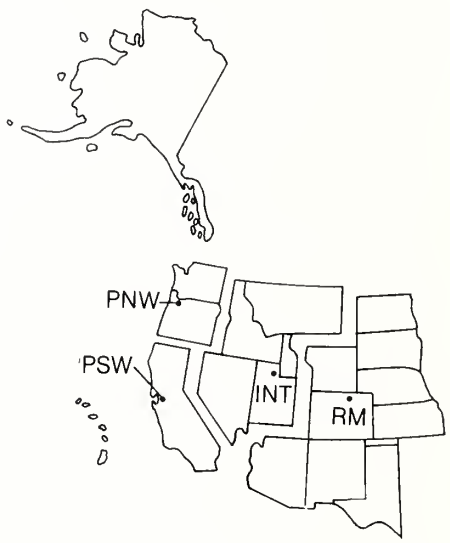
Western Forest Experiment Stations

Pacific Northwest Forest and Range Experiment Station (PNW)
809 N.E. 6th Ave.
Portland, Oregon 97232

Pacific Southwest Forest and Range Experiment Station (PSW)
P.O. Box 245
Berkeley, California 94701

Intermountain Forest and Range Experiment Station (INT)
507 25th Street
Ogden, Utah 84401

Rocky Mountain Forest and Range Experiment Station (RM)
240 West Prospect Street
Fort Collins, Colorado 80526



A classification for Montana's grasslands and shrublands

by Delpha Noble
Intermountain Station

In good condition, the mountain big sagebrush/Idaho fescue habitat type provides valuable livestock summer range and important wildlife habitat.

The Northern Rocky Mountains are a patchwork of forest, shrubland, and grassland vegetation. Species composition and productivity, and the consequent potential values, differ greatly between and within these major vegetation types.

To achieve multiple use planning and intensive resource management on these lands, forest managers are concerned with questions such as:

(1) What are the environmental and vegetative conditions?
(2) What are the productive capabilities of each vegetation type?
(3) How will the land respond to various management activities?

Answers to these questions can be provided, in part, by classification systems such as the habitat type concept developed by Dr. Rexford B. Daubenmire of Washington State University. This concept stresses use of the entire climax plant community as an "environmental integrator," thus permitting identification of environments (habitats) with similar biotic potentials. All environments with the potential to support approximately the same kind of stable (climax) mix of plant species are considered to be within the same habitat type regardless of current successional status. This type of classification provides the framework essential for organizing information on resource potentials, limitations, and responses to management activities.

A new habitat-type classification based upon the potential vegetation of the grasslands and shrublands of western Montana is available. Using the system, land managers and researchers can identify units of rangeland that may be expected to respond similarly to management practices.

The study

Grassland and Shrubland Habitat Types of Western Montana, an illustrated Intermountain Station General Technical Report, describes an intensive reconnaissance study of the nonforested lands of western Montana. More than 350 stands—289 in grasslands, 66 in shrublands—were sampled to develop the classification. General reconnaissance data were obtained from an additional 225 stands to supplement the geographical coverage provided by the intensively sampled areas.

The study leading to the classification system was headed by Walter F. Mueggler, project leader of the Intermountain Station's research work unit concerned with ecology and management of aspen lands in the west. Mueggler and William L. Stewart, currently pesticide specialist on the staff of the Northern Region, Missoula, are coauthors of the report. The Northern Region provided major financial assistance, and Montana State University lent technical support for the study.

Vegetation composition was determined on numerous selected areas throughout western Montana.

The western Montana classification posed a special challenge—livestock grazing for more than 100 years had left few areas unchanged. The scarcity of ungrazed areas required sampling of near-pristine areas as well as areas where some disturbance had occurred.

To represent the mountainous portion of Montana, Mueggler and his team have defined 29 habitat types which can be grouped into 13 climax series. The report contains a "key" for field identification of the types, and a general description of each type. The key covers natural grassland and shrubland vegetation within the lower valleys and foothills up through the subalpine type.

For each of the 29 habitat types listed in the report, Mueggler and Stewart discuss: 1) distribution and environment; 2) vegetative composition; 3) productivity; 4) changes with grazing, and 5) range management implications. Tables included in the report can be used for detailed comparisons.

In addition to their own research, the authors relied upon extensive literature review and the experience of range managers to develop information relevant to the management of each habitat type.

An example

The following excerpts from the section of the report dealing with the Idaho fescue/bluebunch wheatgrass *(Festuca idahoensis/Agropyron spicatum)* habitat type gives an idea of the scope of information included in the publication.

DISTRIBUTION AND ENVIRONMENT.—This is perhaps the most frequently encountered type in southwestern Montana. Although it occurs throughout the western part of the State, it is particularly prevalent on intermediate elevation mountain slopes south of 46° latitude. The type can be found at elevations ranging from 4,500 to 7,500 feet. The habitat type occurs on a wide variety of soil parent materials. The amount of soil surface covered by rock . . . .

VEGETATIVE COMPOSITION.—Bluebunch wheatgrass is always present and more abundant than any of the rhizomatous wheatgrasses, and usually is an obvious codominant with Idaho fescue. The amount of forbs is highly variable, ranging from 10 to 60 percent . . . .

PRODUCTIVITY.—Four different stands were sampled over a 3-year period to evaluate the productivity potential of this habitat type. These stands were selected to span the range in site potential within the type. The best site produced almost twice as much biomass as the poorest site. Production appeared to be greater on the northerly exposures, suggesting that . . . .

Vegetation data were analyzed by computer to determine the community similarities and relationships needed to form the classification.

High elevation mountain grasslands provide excellent summer range for cattle.

CHANGES WITH GRAZING.—Bluebunch wheatgrass and Idaho fescue are the principal species that decrease with heavy grazing in this habitat type. In some instances, Idaho fescue may increase with the reduction of bluebunch wheatgrass, but it will eventually decrease with heavy use. The principal species that usually increase are . . . .

RANGE MANAGEMENT.—Although the Idaho fescue/bluebunch wheatgrass type is perhaps best suited for cattle production, the abundance of forbs, particularly in the western needlegrass phase, makes it acceptable sheep range. The type is widely used by big game animals. Consequently, resource managers should be alert to potential conflicts between wildlife and livestock. The type is used by elk and deer at the lower elevations as winter range, and by antelope year-round. Proper use of the type under cattle grazing should be keyed primarily to . . . .

The classification framework

Mueggler and Stewart's classification first breaks the grassland and shrubland vegetation into series, which are then subdivided into habitat types. In some cases, the habitat types are further broken into phases. An example might be:

Climax Series: *Festuca idahoensis*
Habitat Type: *Festuca idahoensis/Agropyron spicatum*
Phase: *Stipa occidentalis*

Land managers are currently more concerned with series and habitat-type designations. Future demands, however, may require consideration at the phase level.

It has been said that classification is the access key to the manager's information system. The land manager can use the system to predict management opportunities and consequences of selected actions. Classification also provides a framework for further management-oriented research. Basic land units have been identified, to which future research can be tied.

According to Mueggler, development of a habitat-type classification should be based on data from a large number of pristine sites. In the Montana classification, this could be only partly met. Therefore, it is subject to change as more information becomes available, especially for types identified on the basis of relatively few stands.

But the classification system for the grasslands and shrublands of western Montana is ready for use—managers now have another long-awaited tool for effective resource management.

Mine spoil reclamation in the Southwest

by Rick Fletcher
Rocky Mountain Station

In a recent energy message, President Carter called for a dramatic increase in the nation's coal production - from 650 million tons mined in 1975 to 1.2 billion by 1985. The federal government estimates that over 50 percent of U.S. coal production for the rest of this century will be mined by surface methods. However, mining, particularly surface or strip mining, requires disturbing the land.

Although reclamation methods for mine spoils began soon after the turn of the century, economic and technical limitations left most spoils abandoned without any attempt at reclamation.

As technology improved and surface mining became more prominent and widespread, the public began to take notice and demand action to prevent unnecessary damage to mined lands and adjacent areas. This resulted in enactment of strip mine legislation, with the first state laws going into effect in 1939. Today, the majority of states have surface mining and reclamation laws.

The Four Corners area in the Southwest contains some of the richest coal deposits in the West. In 1973, scientists at the Rocky Mountain Station began to look for efficient and effective ways to successfully reclaim spoils left after mining.

Earl Aldon, Project Leader for the Station's Mine Spoil Reclamation unit in Albuquerque, which began under the Forest Service's SEAM (Surface Environment and Mining) Program, explains, "Coal resources in the Southwest are extensive, particularly in northwest New Mexico and northeast Arizona. Reclamation of these strip-mined lands can be a problem due to the climatic conditions. Problems of revegetating strip mine areas in this region differ drastically from those in more humid areas, particularly the East."

Ask Earl what results have come out of these years of research and he'll tell you that plant establishment on Southwestern mine spoils is both practical and feasible. "When we started these studies, people thought that you couldn't grow anything on mine spoils around here. Well, through close cooperative efforts with mining companies, we've helped show that you can," he said.

Proper reclamation involves a multitude of steps and details - far too many to mention in this report, but, there are some basic requirements that need attention to ensure any hope of success. These include site preparation, mulching, and temporary irrigation on low rainfall sites.

Site stabilization

Site stabilization should be one of the first steps in reclaiming mine spoils. This is probably the most expensive, yet necessary step. Failure to stabilize spoil surfaces against raindrop and runoff impacts prior to establishment of vegetation will result in a high degree of rehabilitation failure.

Prevention or reduction of surface runoff and soil erosion can be achieved by a combination of measures that include land shaping, seeding and mulching. Spoils should be shaped to produce as many flat surfaces with short slopes as possible, and, at the same time, leaving the soil surface in a rough or furrowed condition. The resulting topography should, ultimately, increase rainfall retention, infiltration and percolation, increase leaching of spoil salts, and reduce runoff and erosion.

Mulching

Mulches, such as hay, straw, bark, wood chips, etc. are an effective and often times necessary tool for establishing vegetation on Southwestern mine spoils. Mulching insulates the soil against intense solar radiation, reduces evaporation, raises ground temperatures during winter, and lowers them during summer.

Mulches can also break down after ground cover establishment, supplying valuable organic matter to the soil.

Mulching can also reduce the impact of raindrops, help control erosion, and hold seed and seedlings in place.

Scientists at Albuquerque have found that straw is the most stable and long-lasting mulch for the Southwest.

Soon after coal is removed from the mine, the topography is reshaped to smooth contours.

Irrigation

Water is a vital factor to any reclamation effort, especially in the arid Southwest. Moisture is critical for revegetation success during the planting and early establishment phases.

In the Southwest where precipitation is so erratic, irrigation is almost a necessity during the first year to ensure survival and establishment, particularly for shrubs that demand larger amounts of water.

Station scientists have found that when plenty of water is available, such as from wells, reservoirs, etc., the overhead sprinkler system will produce the highest plant density. If available water is in short supply and high plant density is not critical, drip irrigation should be used.

After the first growing season small grass plants germinate in the roughened surface material. Research has shown the roughened topography, treated with mulches, to be necessary for grass germination and survival.

Sprinkler systems are very effective - they give full area coverage, are durable and easily portable. On some steep slopes, however, they may cause an erosion problem. Sprinklers have been successful in a number of applications in reclamation of disturbed lands, but only when the systems were properly designed and operated.

Drip irrigation provides water slowly to a fixed location. It is designed to optimize soil moisture at a specific site. With drip irrigation, less water is used than with any other system - often resulting in a water savings of 30 percent over sprinkler irrigation. Also, a drip irrigation system will generally cause less erosion problems.

Plant species

The Southwest hosts a variety of vegetation. Earl explains that when revegetating mine spoils, chances of success can be improved by using native plants that are best adapted to the local environment.

Although plant species vary according to geographic location, results of studies show that the most promising species to plant in the Southwest are the grasses alkali sacaton, western wheatgrass and Indian ricegrass, and the shrub fourwing saltbush.

Two popular forms of revegetating are direct seeding and transplanting seedlings. Drilling is by far the most common method of direct seeding - mechanically placing the seed at a proper depth and controlling the seeding rate while distributing the seed uniformly.

Transplanting provides a higher survival rate, but is considerably more expensive than seeding. On one study plot in northwestern New Mexico, 24 percent of seeded plants emerged and were surviving one year after seeding, compared to a 100 percent survival rate for transplanted plugs one year after planting. Scientists are now working on ways to reduce the costs of transplanting.

After five years, these shrubs are reseeding themselves and spreading to adjacent areas. Note the spread of grass plants in the foreground.

Soil communities

Scientists with the Albuquerque project have recently been scrutinizing soil organisms that influence physical and chemical characteristics of mine spoil material. Undisturbed or natural soils contain a balanced assemblage of bacteria, fungi, and insects which make up the soil community. These organisms process dead plant material and convert it into mineral soil, fix nitrogen, redistribute soil particles, improve aeration, and generally have an enhancing effect on the soil structure. Mine spoils, however, usually lack this biological soil community. As a result, research scientists began to look at ways to establish a soil biota, as well as a supportive organic substrate for the soil organisms.

Knowing that termites occur naturally on unmined areas in the Southwest, researchers wanted to know what affect termites could have on revegetating mine spoils. Results of these studies show that under lab conditions, marked differences occurred between spoils untreated and termite-worked spoils. Termite activity made the soil more friable and uniform. The insects also helped to break up large chunks and mixed the soil, producing a desirable sand-clay-loam texture. Overall, their activity enhanced porosity, percolation and aeration of the substrate. Scientists are now working to find ways of establishing termite colonies on mine spoils in the Southwest.

After several growing seasons, the wheatgrasses planted here show good density and vigor. Research is nowunderway to determine the best management practices needed to use and perpetuate these revegetated sites.

Reclamation techniques have changed dramatically in the last decade, primarily due to the intense interest and concern of the public. Approaches previously considered impractical and unrealistic are now being proven. Results from years of research on mine spoil reclamation are now being used at several mining sites in the Four Corners area.

Research has, by no means, answered all the questions associated with mine spoil reclamation in the Southwest, but, with additional studies and cooperative efforts between universities, mining companies, government agencies, and others, the development of practical solutions to the most pressing problems can be found.

There are many details that need attention when dealing with mine spoil reclamation. This article has touched only on a few. For additional information, contact Earl Aldon, Rocky Mountain Forest and Range Experiment Station, Forestry and Range Sciences Laboratory, 5423 Federal Building, 517 Gold Ave. S.W., Albuquerque, New Mexico 87101. Phone (505) 766-2384, FTS - 474-2384.

Publications suggested for further reading are: *The Use of Termites and Other Soil Fauna to Develop Soils on Strip Mine Spoils*, Research Note RM-361-FR21; "Reclamation of Coal-mined Land in the Southwest", a reprint from the *Journal of Soil and Water Conservation*, March-April 1978 issue, Volume 33, Number 2; "Demonstration Test of Two Irrigation systems for Plant Establishment on Coal Mine Spoils", a reprint from the proceedings of the *Fourth Symposium on Surface Mining and Reclamation*, NCA/BCR Coal Conference and Expo III in Louisville, Kentucky, October 1976. These publications are all available upon request from the Rocky Mountain Station.

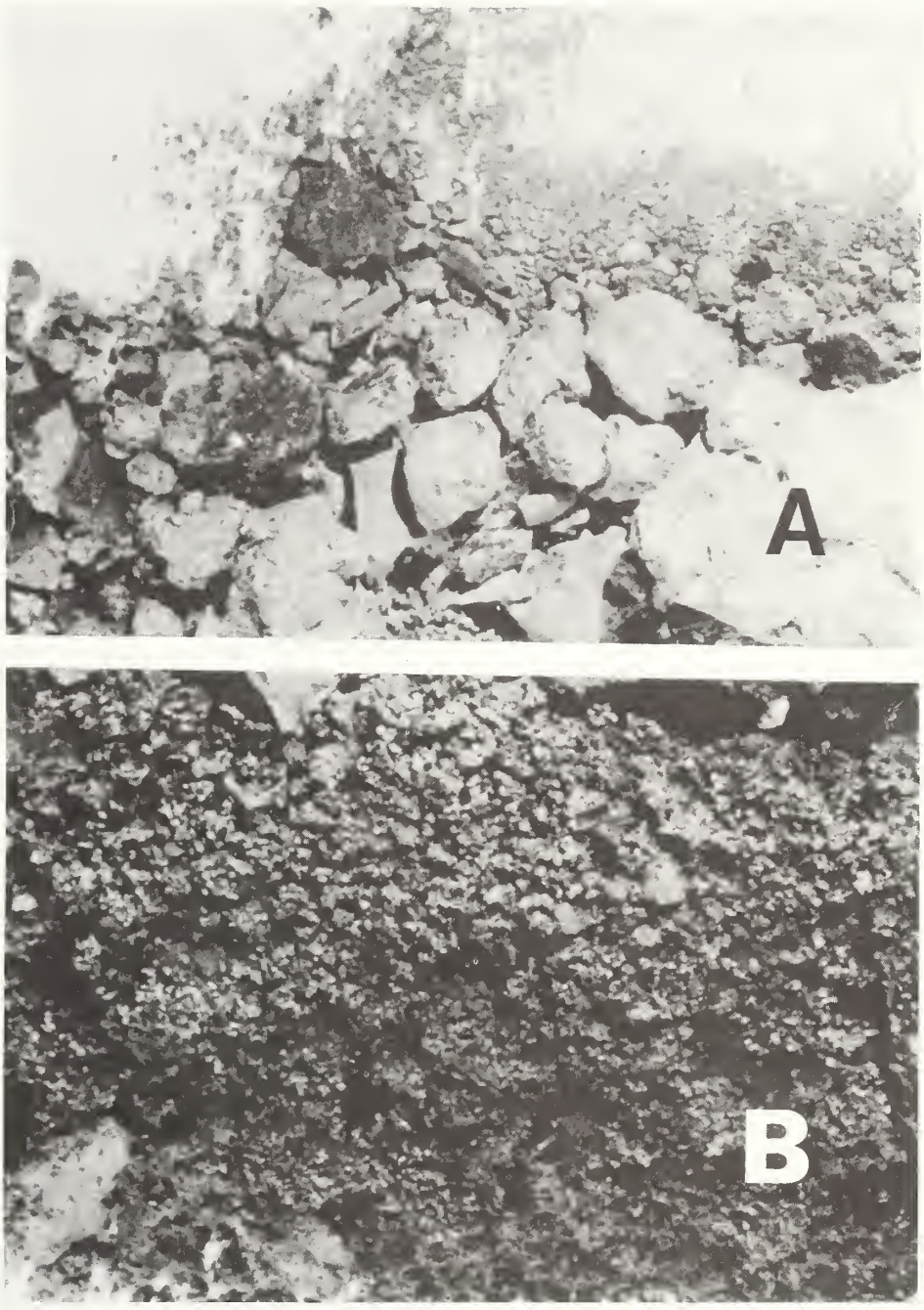


Figure (A) shows raw spoils. Figure (B) shows soil that has been subjected to termite activity. The insects helped to break up large chunks, mix the soil, and give it a more friable and uniform texture - desirable for planting seeds or seedings.

Forestry challenges in Hawaii and Micronesia

by Marcia Wood
Pacific Southwest Station

For all of their exotic charm and natural beauty, the Hawaiian Islands and the island nations of the Western Pacific are not without problems. According to scientists at the Pacific Southwest Station's Institute of Pacific Islands Forestry in Honolulu, the wildland management problems they are trying to solve in Hawaii and the Pacific Basin are just as difficult as those facing their research colleagues on the mainland U.S.

In cooperative studies with the Hawaii Division of Forestry, University of Hawaii, Bernice P. Bishop Estate, C. Brewer Corporation, U.S. Fish and Wildlife Service, U.S. National Park Service, and many other organizations, the researchers are trying to answer such questions as:

- What is causing native ohia forests to decline, and how can this decline be stopped?
- What can be done to reestablish native forests of mamane-naio?
- What are the best ways to plant, manage, and harvest stands of native and introduced trees, so that Hawaii and Micronesia can be less dependent on imported wood?
- What can be done to save Hawaii's endangered forest birds from extinction?
- What are Micronesia's soil and vegetation resources, and what are the best ways to manage them?

The Institute's staff of some 40 scientists, technicians, and others, works in four different teams, specializing in research on timber and watershed management, insects and diseases, native Hawaiian ecosystems, and forest management in Micronesia and nearby areas.

Timber research

Scientists in the Timber and Watershed Management Unit, led by Research Forester Roger Skolmen, are conducting more than 40 studies, ranging from experiments with management of native hardwoods to studies of the water quality problems that may result from the dieback of rainforests of ohia and treefern. Much effort is going into improving the quality of the eucalyptus species that are grown in Hawaii. The performance of eucalypts raised from seed obtained from superior trees in Australia, Brazil, and other countries is being compared. Other tree improvement work is being done with *Acacia koa*, Hawaii's most valuable native hardwood. Skolmen has tried several vegetative propagation techniques, in attempts to clone superior koa, and has been very successful with a technique known as tissue culture. This technique involves removing tissue from superior parent trees and nurturing it in the laboratory, in special cultures, to produce superior plants.

The Pacific Islands Unit played a major role in mapping the soils and vegetation of many Micronesian islands.

The dibbling tube system is a carefully planned approach to raising, shipping, and outplanting containerized seedlings.

Skolmen's success in raising koa clones by tissue culture is notable, because few forest trees have been propagated this way.

The Unit is also helping with an experiment to convert 200 acres of marginal quality pastureland on the Island of Hawaii back to a productive koa forest. This experiment, and others, will provide guidelines on how to manage koa. This information should be of interest not only to landowners who want to manage koa on their property, but also to environmentalists concerned with the rapid depletion of native koa forests.

The system that the Unit developed for raising containerized seedlings has been adopted by the Hawaii State Division of Forestry and is being used, with good results, for raising some of the more than 4 million seedlings needed each year for planting watersheds, eroded areas, and other sites throughout The Islands. Specially shaped containers called "dibbling tubes" are used for growing the seedlings. The racks for holding these tubes, a special box for packing and shipping the racks and carrying them around the planting sites, and a tool for placing the tubed seedlings in the ground, were each designed by the Unit. The system is now being refined—the precise amounts of light, warmth, and moisture needed in the nursery, and the nutrients that will get the best growth of species such as koa and saligna eucalyptus, are now being determined.

The Unit is cooperating with C. Brewer and Company's Bioenergy Development Corporation in experiments of intensive cultivation of "energy plantations" of eucalyptus and legumes. Fiber or chips from these trees would be used to supplement or replace sugar cane residue (bagasse) currently used to fuel boilers and generate electricity at Hawaii's sugar cane mills. Electrical energy not needed at the mills is sold. The new energy plantations should make even more energy available, and reduce the need for costly imports of fuel oil. Plans call for the eucalypts to be harvested every 5 or 7 years, and for coppice management, in which the sprouts emerging from stumps after logging will provide the next forest.

Watershed studies

The team's watershed management work includes careful monitoring of sediment discharged from ohia decline sites, and comparison of the soil characteristics in declined forests with those on healthy sites. The concern is that the decline may affect the quality or quantity of water flowing from ohia watersheds. This concern is justified—water is Hawaii's number one forest product, and most of it is so pure that it doesn't need chlorination or any other type of treatment.

In a related experiment, groundwater tables on healthy sites are being compared with those on decline sites, to see if perhaps high water table levels are keeping ohia roots waterlogged and subjecting the trees to the extra stress of having to transpire more water than trees in healthy stands.

Insects and diseases

The Forest Protection Research Unit is also working on the ohia decline. The problem is one that so far has been tackled by researchers not only at the Institute, but also at the University of Hawaii, Bishop Museum, State Division of Forestry, and a host of other organizations. While each has been able to contribute new information about the decline, none has been able to pinpoint the cause, or to indicate how it could be controlled. Studies of what were, until recently, two of the most suspect organisms in the decline—the ohia borer *Plagithmysus bilineatus* and the root disease *Phytophthora cinnamomi*, ended with the conclusion by Station and Bishop Museum scientists that the organisms—while playing a major role in the decline—are not the key culprits. According to Charles Hodges, the Institute's Director and the leader of the Forest Protection Unit, his group's emphasis will now be on site factors—differences in temperature, slope, elevation, aspect, soils, and similar environmental conditions that might play a role in the decline. This will involve comparing conditions on healthy sites with decline areas—forests on soils formed from flows of the aa type of lava, for example, will be compared with stands on pahoehoe flows.

In an area of study that is new for the Unit, the scientists plan to study the Formosan termite, a seemingly unstoppable pest that destroys homes and other buildings at a much faster rate than continental U.S. termites. The Formosan termite normally lives in underground nests but is able to establish new, above-ground colonies inside homes when conditions are right. "Normal control measures, for the most part, are unsuccessful," says Hodges. "A home may be fumigated, but this will only kill termites already inside the house. It won't prevent termites living in underground nests from re-entering the home, once the fumigant has settled."

Formosan termites are especially formidable enemies—they are more voracious than mainland termites, and their colonies have greater numbers of individuals. Because of Hawaii's mild climate, the Formosan termites can work year-round, 24-hours-a-day. The insect thrives in Hawaii's humidity, and causes some $22 million of damage each year. The Institute's termite research began in mid-1979, with a grant to the University of Hawaii for research on insecticides that might be used to control this pest.

Endangered birds

The wildlife biologists, research foresters, and others in the Native Hawaiian Forest Ecosystems Unit are finding out which natural elements in native forests are vital to the survival of some of Hawaii's 20 species of endangered forest birds. On the Island of Kauai, for example, at the Alakai Swamp Wilderness, Project Leader C.J. Ralph has a crew that regularly tries to locate and unobtrusively observe native birds such as the Kauai thrush, 'o'o'a'a, 'o'u, 'i'iwi, 'elepaio, akepa, and Kauai creeper, and introduced species, including the Chinese thrush, Japanese white-eye, cardinal, and house finch. Their purpose is to find out what the birds eat, how they interact with each other, and what portions of the forest environment they use for nesting, feeding, and other activities. Also of interest is the growth and flowering of the trees and other plants that provide food for the birds. This research will answer such questions as what types of birds use different species of trees? How many flowers and fruits do these trees produce, and at what times of the year? Does the food supply seem sufficient? Working conditions are far from ideal—the Swamp receives more than 200 inches of rain a year!

The group is also concerned about the uncertain future of the palila, an endangered bird that is dependent upon the native forests of mamane and naio for food and shelter.

More needs to be known about the habitat requirements of native forest birds such as the 'i'iwi. (Photo by Dina Kageler, National Park Service).

Now banded, these birds will be released; their activities and their use of the forest will be monitored.

Damage to these forests by feral animals, especially sheep, has pushed the palila almost to extinction. The team is experimenting with ways to improve regeneration of mamane, and is comparing mamane growth on plots that have been fenced (to exclude browsing and grazing animals) with plots that are open. Their aim is to provide information on how to reestablish healthy, vigorous stands of mamane and naio in areas where these trees once flourished.

Micronesian forests

The Institute's role in Micronesia is developing gradually, as former Districts of the U.S. Trust Territory of the Pacific Islands become independent entities. Efforts are hindered by the vastness of Micronesia—2,000 islands and atolls spread out over an area the size of the continental U.S. Then, too, customs and courtesies of the local islanders must be learned and honored—permission to enter clan or community lands to study the forests must be gained, and community support of research goals must be developed. This, coupled with the lack of regular transportation to and from the far-flung research sites, makes the work of the Territories Unit especially difficult. Craig Whitesell, leader of the research in the Trust Territory, Guam, the Northern Mariana Islands, and American Samoa, says his group is starting by establishing trials of promising forest trees on government and privately owned sites, and by forming an information service for Pacific Basin foresters. In addition, the Unit is coordinating new surveys of the soil and vegetation resources of Micronesia. Through the combined efforts of the Unit, the Soil Conservation Service, Pacific Northwest Station, Peace Corps, and island officials, the information needed to draw up soil-vegetation maps for Palau, and for all 4 of the Federated States of Micronesia—Yap, Ponape, Kosrae, and Truk—has been gathered. The maps and accompanying reports should be available within a year. This project is the most extensive soil-vegetation mapping effort attempted in Micronesia.

The information service that the Unit now offers consists of answering questions that come into the Honolulu office about Micronesian forestry, conducting literature searches, and providing documents on tropical forestry for land managers throughout the Pacific. Whitesell explains that this new "Pacific Islands Forestry Information Center" is being patterned after WESTFORNET—the Western Forestry Information Network, a system that offers complete library services to foresters in the Western U.S.

The Timber and Watershed Management Unit's success in raising clones of Acacia koa *in laboratory cultures provided a new way to produce outstanding progeny from the small number of superior koa that now remain in The Islands.*

The Unit is also investigating the plight of the Yapese fruit bat, whose numbers are declining. The fruit bat is considered a delicacy by many Mariana Islanders, and Whitesell doesn't see any hope for a let-up in the bat's popularity as a gourmet item. Those who relish it, boiled (fur and all), and (often) served in a platter of coconut milk, will gladly pay $21 or more to dine on fruit bat. The research includes learning more about the bat, its habitat requirements, and what can be done in the way of forest management to build up bat populations to the point that they can sustain periodic harvesting.

Further information about the research described here is available from the project leaders named. Write to them in care of the Institute of Pacific Islands Forestry, 1151 Punchbowl Street, Honolulu, Hawaii 96813, or telephone (808) 546-5669.

Researchers in the Hawaii Forest Protection Unit are trying to determine what's causing the decline of native ohia forests.

A new outlook for wildlife

by Dorothy L. Bergstrom
Pacific Northwest Station

A new system for organizing information about wildlife is now helping forest managers account for the welfare of resident wildlife in managed forests. The system was developed for use in the Blue Mountains of Oregon and Washington but is generally applicable to managed forests throughout the United States.

The system provides a practical way to predict the effects of forest management on wildlife. It is based on two assumptions: (1) timber management is the dominant activity in managed forests, and (2) by altering habitat, timber management affects wildlife more than any other management activity. The system provides a type of bifocal vision that helps managers view a given forest area from the viewpoint of wildlife without losing sight of timber production goals.

The need for such a system has grown in recent years as new legislation has increased and defined the responsibility of forest managers for the whole spectrum of wildlife species. The National Environmental Policy Act, passed in 1969, directs managers of Federal lands to evaluate the effects of federally financed projects on all species of resident wildlife. The Endangered Species Act of 1973, the Forest Management Act of 1976, and other Federal laws have broadened the accountability of forest managers for wildlife. In many states, similar laws now influence the management of State and private lands.

The system was developed by a professional team led by wildlife biologists at the Pacific Northwest Station's Wildlife Habitat Laboratory in La Grande, Oregon. Others who cooperated in conceiving and developing the system were forest managers in the Blue Mountains, and scientists and resource specialists of many disciplines from Federal and State agencies and universities in Oregon and Washington. The system is described in a book published recently by the Forest Service titled *Wildlife Habitats in Managed Forests. The Blue Mountains of Oregon and Washington.* Although the data supplied are specific to the Blue Mountains, the principles and practices described can help field foresters elsewhere account for the welfare of wildlife.

In the past, foresters had no good way to estimate how their management actions would affect resident wildlife. Animals don't report shortages of food or nesting sites or notify foresters when they leave an area because conditions have become unsatisfactory. What happens, for example, when large tracts of insect-killed timber are cut? That question was raised in the Blue Mountains when managers were planning to salvage timber damaged by the 1971-74 outbreak of the Douglas-fir tussock moth. Although wildlife biologists in the Blue Mountains knew a great deal about wildlife species and their habitat needs, the information was not organized to answer this question. Biologists began working with forest managers to translate knowledge about habitat needs into guidelines to protect habitat during salvage operations. The resulting guidelines so impressed the supervisors of the four National Forests in the Blue Mountains that they asked for expanded guidelines for all types of forest management and land-use planning.

Wildlife Biologist Jack Ward Thomas, leader of research at the La Grande Wildlife Habitat Laboratory and technical editor of the book, says what happened next was the beginning of the new system: "When managers tried the expanded guidelines and found them too rigid to apply to individual situations," he says, "we changed our approach and came up with something better—a predictive system that doesn't tell the manager what to do but provides a tool to determine how various management actions are likely to affect wildlife. The system helps the manager to make decisions and be accountable for them."

Grouping wildlife according to habitat needs

The initial step in organizing the vast amount of available information was to classify wildlife species into groups according to their use of the same type of habitat. After assembling detailed information on each of the 378 resident species of amphibians, reptiles, birds, and mammals in the Blue Mountains, the cooperators found they could divide these into 16 groups, or life forms, according to their habitat needs. The detailed information on each species and each life form was organized in 29 inter-related appendices which make up the bulk of the book.

Life form	Reproduces	Feeds	No. of species[1]	Examples
1	in water	in water	1	bullfrog
2	in water	on the ground, in bushes, and/or in trees	9	long-toed salamander, western toad, Pacific treefrog
3	on the ground around water	on the ground, and in bushes, trees, and water	45	common garter snake, killdeer, western jumping mouse
4	in cliffs, caves, rimrock, and/or talus	on the ground or in the air	32	side-blotched lizard, common raven, pika
5	on the ground without specific water, cliff, rimrock, or talus association	on the ground	48	western fence lizard, dark-eyed junco, elk
6	on the ground	in bushes, trees, or the air	7	common nighthawk, Lincoln's sparrow, porcupine
7	in bushes	on the ground, in water, or the air	30	American robin, Swainson's thrush, chipping sparrow
8	in bushes	in trees, bushes, or the air	6	dusky flycatcher, yellow-breasted chat, American goldfinch
9	primarily in deciduous trees	in trees, bushes, or the air	4	cedar waxwing, northern oriole, house finch
10	primarily in conifers	in trees, bushes, or the air	14	golden-crowned kinglet, yellow-rumped warbler, red squirrel
11	in conifers or deciduous trees	in trees, in bushes, on the ground, or in the air	24	goshawk, evening grosbeak, hoary bat
12	on very thick branches	on the ground or in water	7	great blue heron, red-tailed hawk, great horned owl
13	in own hole excavated in tree	in trees, in bushes, on the ground, or in the air	13	common flicker, pileated woodpecker, red-breasted nuthatch
14	in a hole made by another species or in a natural hole	on the ground, in water, or the air	37	wood duck, American kestrel, northern flying squirrel
15	in a burrow underground	on the ground or under it	40	rubber boa, burrowing owl, Columbian ground squirrel
16	in a burrow underground	in the air or in the water	10	bank swallow, muskrat, river otter
		Total:	327	

[1]Species assignment to life form is based on predominant habitat-use patterns.

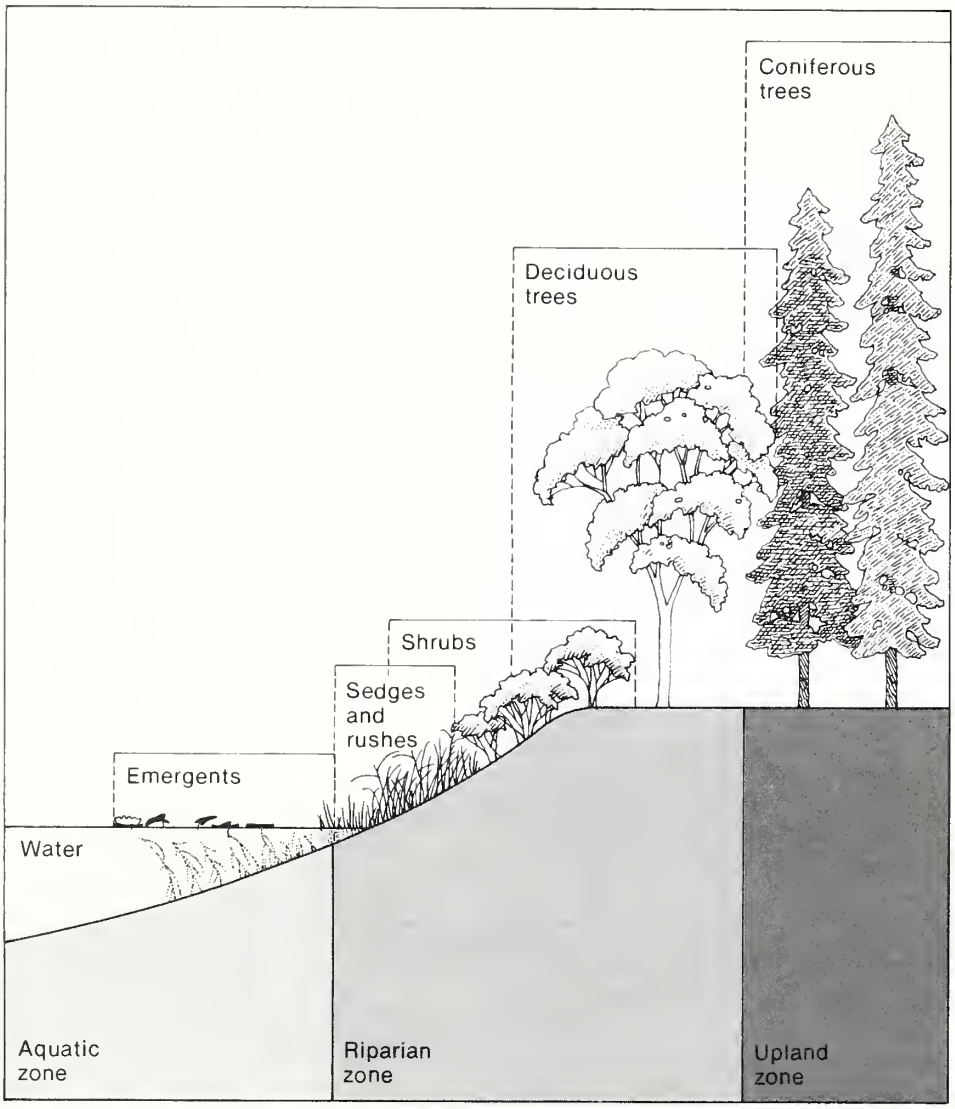
Wildlife in the Blue Mountains was classified into 16 life forms based on predominant use.

Plant communities and successional stages

One chapter of the book shows managers how to use the appendices and bring the large volume of technical information about wildlife into equal focus with timber management. The familiar sites, stands, and stand conditions are described as the plant communities and successional stages that make up wildlife habitat. Managers can visualize how wildlife species in an area change with natural vegetation succession or with management changes. They see how decisions about the timing, methods, and equipment used to cut timber, plant and fertilize trees, control insects, treat slash, and build roads will affect resident wildlife.

Edges

Edges are the borders where two plant communities or successional stages meet. They are particularly important to wildlife because the greater variety of vegetation in the overlapping areas provides habitat for a greater diversity of wildlife. By planning ahead for the amount of edge and the way it is arranged, foresters can adjust timber management activities to maintain the diversity and stability of wildlife populations without sacrificing timber production goals.



The vegetation changes with distance from water source.

Riparian zones

Riparian zones have characteristics that make them important for many uses. Timber usually grows well along streams, and grass provides good grazing for both wildlife and cattle. Riparian zones are also attractive locations for campgrounds and recreation use, and are often the location of roads.

Wildlife also use riparian zones more than any other forest area. The greater diversity of plant species increases edge effect and provides rich habitat. The microclimate may be particularly important to certain species. Animals also use riparian zones as migration routes and travel connectors between forested areas. Of the 378 vertebrates in the Blue Mountains, 285 species are directly dependent on or use these areas more than other habitat.

Riparian areas also tend to be the most vulnerable to management mistakes. Forest managers planning activities that involve these areas, are advised to take a long, careful look and consult wildlife and fishery biologists during the planning stages.

Dead and down woody material

In terms of timber management, the woody material left on the ground after timber harvest is often considered "unsalvaged mortality," a wasted resource, and a fire hazard. But wildlife biologists see this material, plus the dead limbs and logs that fall naturally to the forest floor, as potential wildlife habitat. In varying stages of decay, this wood serves wildlife in a variety of ways. For example, logs and elevated limbs and root wads become perches, lookouts, and sites for feeding and dusting. Spaces under loose bark offer hiding and thermal cover for small vertebrates. Slash provides escape cover for birds and small mammals.

Logs are particularly important because they persist a long time on the forest floor. Protected areas under logs provide nesting, hiding, and thermal cover for a variety of birds and mammals. Logs also help stabilize streams. They form pools and short waterfalls which increase the variety of stream habitat and the organisms which are food for vertebrates. As they gradually decompose, logs also contribute to a new forest by gradually releasing nutrients and recycling minerals.

Through careful planning, forest managers can provide for wildlife needs without interfering with timber goals. Logs can be moved away from slash to be burned and placed along the contour of slopes or abutted against the uphill side of sound stumps. Logs imbedded in streams can be left untouched when fresh debris is being removed. Slash can be retained for wildlife cover on a portion of a clearcut area but should not block the established trails of big game or livestock.

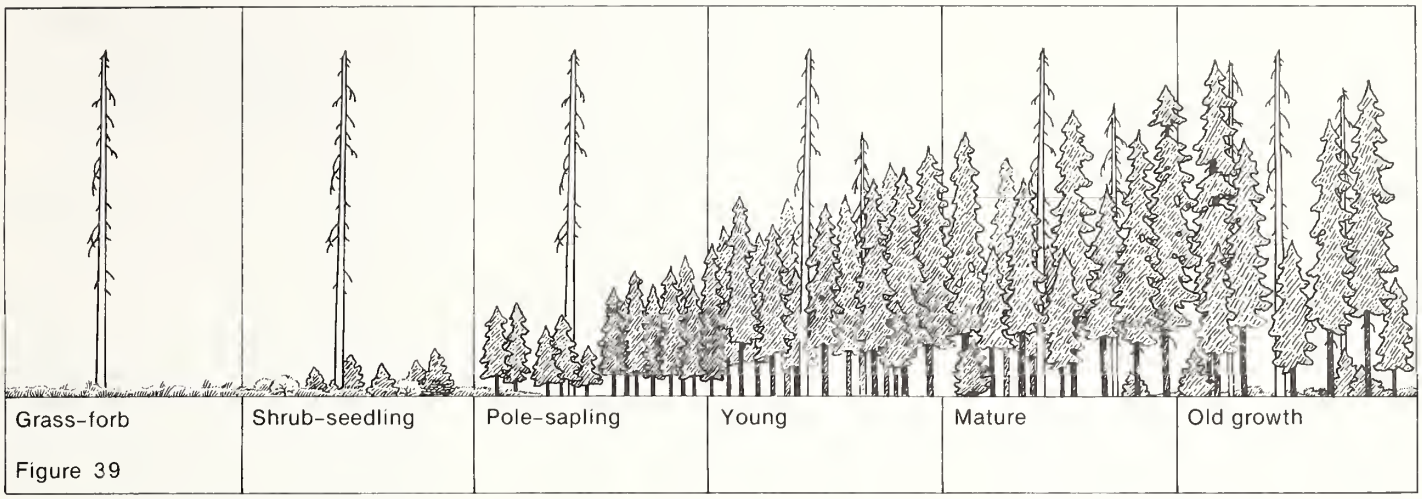


Figure 39

Use of snags by wildlife is influenced by the successional stage of the surrounding forest.

Snags

Each stage in the gradual decay of snags has value for certain wildlife species. In the Blue Mountains, 39 birds and 23 mammals use natural or excavated cavities for nesting, raising young, roosting, and hibernating. Eighteen of the bird species excavate their own holes in snags, some in hard snags, others in soft snags. Vacated cavities in decayed wood and under bark are used by still other species. The insects found in snags and other woody material are important food for many species. Although the importance of vertebrate wildlife in controlling insect populations is not yet fully understood, predation of insects by birds appears to be much greater than previously estimated.

The successional stage of a stand surrounding snags is also important. For example, blue birds and house wrens use cavities in snags in the grass-forb or shrub-seedling stages but not in more advanced successional stages.

Appendices explain how to choose a wildlife population level as a goal and how to select the right number, kind, and distribution of snags to provide current and future homes for the desired population.

Cliffs, talus, and caves

Cliffs, talus, and caves are examples of unique habitat provided by geomorphic features which are not usually of much concern in timber management. Although these features make up a very small percentage of the total forest, they are disproportionately important habitat for many vertebrate species, including bats, raptors, coyotes, lizards, and snakes. Cliffs, for example, provide fissures, ledges, caves, and loose slab rock which offer roosting, nesting, and hibernation sites. In the Blue Mountains, 32 species reproduce in cliffs, talus, and rimrock.

The nearby plant communities are also important as sources of food, and snags along the tops of cliffs provide essential perches for raptors.

Forest managers need to recognize these geomorphic features as important and relatively rare habitat. Management activities that disturb or alter this type of habitat should be evaluated with the assistance of wildlife experts. Protection of such areas often includes eliminating the human disturbance caused by travel on nearby roads and trails, cave exploration, and removing talus for road building.

Featuring selected wildlife

In addition to using the new system to predict the effects of management on resident wildlife, managers can reverse the process and actively enhance habitat for selected species which are endangered or require special protection. They can also favor species selected for special emphasis. Deer and elk, for example, are of particular importance in the Blue Mountains, and their special requirements in addition to food and water are described in a separate chapter. Because of their large size, deer and elk need the hiding and thermal cover provided by large timber and corridors of vegetation in which they can travel safely from cover to forage areas.

The biological needs of deer and elk can be met under a variety of timber stand rotation ages and intensities of management, but providing the thermal and hiding cover, fawning/calving areas, and protected corridors requires planning. Management activities should be restricted to the smallest area, for the shortest possible time. Operations should be restricted to a single drainage and adjacent areas maintained undisturbed. It is particularly important to look at travel lanes, roads, and open areas from the viewpoint of a big game animal that does not want to be seen.

Silvicultural options

On public lands it is not a question of deciding whether to produce both timber and wildlife. It is required by law. Equitable trade-offs between the two require creative skill of the forester and wildlife biologist. The manager has several options for manipulating vegetation. These include adjustments in the scheduling of management activities, in the arrangement of stands in both time and space, in the size of treatment areas, and in fitting these factors to the land type involved. By skillful use of these options managers can provide for all resident wildlife, favor selected species, or a combination of these objectives.

Impact on wood production

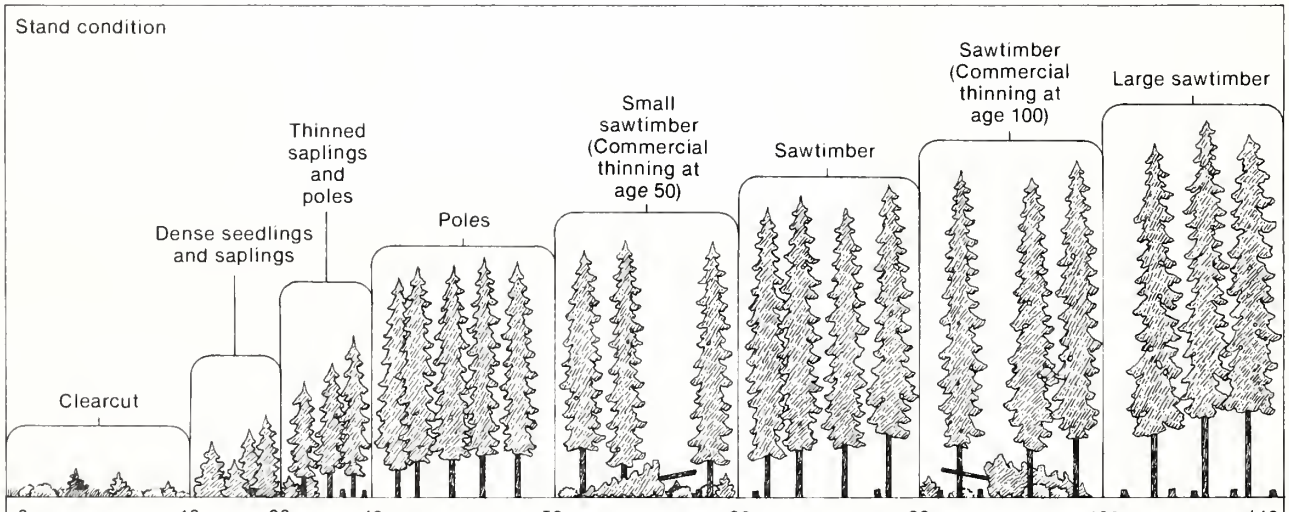
Managers should also be able to evaluate the costs of providing wildlife habitat in terms of the impact on wood production. The technique used compares estimates of wood production under two timber management goals. One is designed to produce the maximum cubic volume of wood, the other modified to provide desired habitat. The key to the technique is to construct yield tables that reflect these goals and to do this by modifying commonly used timber management techniques. The Forest Service uses the stand projection model called timber RAM (Timber Resource Allocation Model) to calculate timber harvest levels. Examples are given which demonstrate how to evaluate the impact on wood production of two management schemes, one designed to provide snags for cavity users, the other old-growth habitat.

Book now available

In the process of collecting facts and expert opinion and deciding how to organize the information for forest managers, the 16 authors and 44 major contributors to the book accomplished something more. They have introduced a new approach to wildlife management which is already influencing the practice of forestry across the United States. While the book was still being written, Thomas and others were responding to invitations to explain the new approach at professional meetings. "The system evidently fills a need, even though we don't have all the answers about habitat use," Thomas says. "Drafts of the book have been circulating around the country for a couple of years now."

Forest managers who have worn-out drafts of the book can now replace them with the new, 512-page, color-illustrated book, *Wildlife Habitats in Managed Forests, The Blue Mountains of Oregon and Washington,* Jack Ward Thomas, technical editor, Agricultural Handbook 553. Copies are available, at $14 each, only from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

A 140-year timber rotation designed to provide different habitat needs of elk.



Habitat for elk						
Forage area	Hiding cover	Thermal cover	Forage area	Thermal cover	Forage area	Thermal cover
Forage is abundant	Sight distance is less than 61 meters (200 ft) from age 10 to 20 years or 7 percent of the rotation. One-quarter of the trees are thinned at stand age 20 to encourage growth but maintain hiding cover for 30 years or 20 percent of the rotation.	As the trees grow, crowns close and tree height reaches at least 12 meters (40 ft). Thermal cover is provided for 10 years or 7 percent of the rotation.	About 30 percent of the trees are removed in a commercial thinning. Thermal cover is destroyed and the area is now a forage area.	Tree crown cover is now over 70 percent. Thermal cover is provided for another 10 years or 7 percent of the rotation.	A second thinning removes another 30 percent of the trees, destroys thermal cover, and creates a forage area.	Thermal cover is restored the last 10 years prior to regeneration cut. Three 10-year periods of thermal cover amount to 30 years or 20 percent of the rotation.

New publications

Natural regeneration of true fir

With the proper use of any one of several regeneration cutting systems and patterns, it is possible to get good natural regeneration of white fir and California red fir. This is a statement Research Forester Donald T. Gordon makes, and proves, in his new report, *Successful Natural Regeneration Cuttings in California True Firs,* Research Paper PSW-140. Gordon, an authority on true fir management, acknowledges the difficulties many silviculturists have had in the past with natural regeneration of true fir. He says, however, that they can now "use with confidence" the seed tree and clearcut systems he tested in his experiments.

Gordon used more than 90 cutting areas on Swain Mountain Experimental Forest in northeastern California for the study. These were, primarily, clearcut strips 1, 2, or 3 chains wide and 6 chains long, clearcut squares of 2 by 2, 3 by 3, or 4 by 4 chains, and seed tree cuttings with 10, 20, or 30 leave trees per acre. His results, from monitoring plots for 3 years after logging, showed that stocking was better than 50 percent on 83 percent of the plots. Wind or snow damage to the stands surrounding the cutover sites was comparable to that sustained by the untreated old-growth. Seed tree cuttings suffered the least damage, a finding that Gordon says "shows it is possible to select trees which will produce abundant seed and yet not yield to normal wind storms."

On most of the plots, competition from herbs, brush, and similar vegetation was not a problem. Gordon emphasizes that a good supply of sound seed and a carefully prepared mineral soil seedbed are critical elements in any attempt to get adequate natural regeneration. But, once these two criteria are met, well-planned regeneration cuttings should result in adequate stocking of true fir stands. He describes related findings from the study in the Research Paper; copies are available from the PSW Station.

Wildlife in managed rangelands

Two short publications about wildlife habitat in southwestern Oregon concern management of riparian zones and manmade habitats. They are the first in a projected series of 14 publications which are specific to the Great Basin of southeastern Oregon but describe principles and processes that are applicable to all managed rangelands.

Riparian zones are especially important to wildlife in rangelands, and are critical for some species. Riparian zones make up a minor proportion of rangelands but are more productive of both plants and animals while providing a critical source of diversity. Management planning should give special attention to activities which disturb riparian habitat and should include wildlife and fishery biologists in the planning process.

Abandoned manmade structures are viewed by many people as reminders of the Nation's historic past. They also resemble the natural habitat of a variety of vertebrate wildlife. Abandoned buildings, machinery, root cellars, refuse pits, fences, and irrigation ditchs provide reproductive sites, perches, and other needs of about 500 species of birds, reptiles, amphibians, and mammals. With careful planning these structures can be managed for the welfare of wildlife and simultaneously enjoyed by people.

Riparian Zones by Jack Ward Thomas, Chris Maser and Jon E. Rodiek, General Technical Report PNW-80, and *Manmade Habitats* by Chris Maser, Jack Ward Thomas, Ira David Luman, and Ralph Anderson, General Technical Report PNW-86, are available from the Pacific Northwest Station.

Increasing water yield in the Colorado River Basin

The combined surface and ground water supplies in the Colorado River Basin are generally adequate for current needs. However, growing demands and use of water in the Basin could result in a widespread water shortage by 1995.

A new report describes how water yield from forests and rangelands in the Basin can be augmented by managing vegetation and snow to reduce evapotranspiration. The report covers most vegetation types in the Basin, and the potential increase in water yield that could be expected from each as a result of different land management practices. Costs, time frames, and other considerations are covered.

For a copy of this report, write the Rocky Mountain Station and request *Managing Vegetation to Increase Flow in the Colorado River Basin,* General Technical Report RM-66-FR21, by Alden R. Hibbert.

Managing western hemlock and Sitka spruce

A new report summarizes the current knowledge on the silviculture of western hemlock and Sitka spruce forests and provides practical information on managing these forests for timber production. Major sections are devoted to descriptions of the hemlock-spruce type, silvicultural systems, regeneration, planting, thinning, fertilization, growth and yield, protection of forest and soil, and relationships to other forest uses. The emphasis is on Oregon, Washington, and Alaska, but the information and silvicultural recommendations apply in British Columbia as well.

Copies of *Management of Western Hemlock-Sitka Spruce Forests for Timber Production* by Robert H. Ruth and A. S. Harris, General Technical Report PNW-88, are available from the Pacific Northwest Station.

Larch casebearer—unwanted immigrant

An unwanted immigrant—the larch casebearer—was first found in the United States in 1886. Discovered in Idaho in 1957, it has become the most serious insect enemy of western larch forests.

A comprehensive discussion of the knowledge accumulated on the biology, ecology, and control of the larch casebearer since its discovery in the West is available in a recent Intermountain Station publication, *Larch Casebearer in Western Larch Forests*, INT-GTR-55-FR21 by Robert E. Denton, formerly principal entomologist at the Station's Forestry Sciences Laboratory, Moscow, contains considerable information about the casebearer that has not been published. Although the paper is concerned primarily with the casebearer in western North America, studies in the East and in Europe are cited where pertinent.

The publication includes sections on biological and chemical control of the casebearer, and discusses future prospects for infestations in the West.

The Intermountain Station can provide copies of the report.

Douglas-fir regeneration studied

Foresters who are planting Douglas-fir on cutover sites in northwestern California may have the best success with north-facing, tractor-logged sites that are below 3,000 feet in elevation, according to the results of a new survey. The survey further shows that small cutblocks will probably turn out to be more fully stocked than larger ones.

The survey was made by Research Forester R. O. Strothmann of the Pacific Southwest Station, and is described in his publication, *Regeneration of Douglas-fir Cutblocks on the Six Rivers National Forest in Northwestern California*, Research Paper PSW-142. The 61 cutblocks that Strothmann sampled ranged in size from 6 to 68 acres and from 1,300 to 4,900 feet in elevation. Some had been planted as recently as 1975, others dated back to 1964. His purpose was to find out how such factors as logging method, cutblock size, or years since planting, affected regeneration success.

Strothmann points out that some results—such as those concerning the aspect or age of the plantations—"conform to expectations, and can be accounted for by well-established biological relationships," while others, such as the findings about elevation, are more difficult to explain.

He found that the most favorable aspect for regeneration was about 12 degrees east of north, and the least favorable about 12 degrees west of south. He attributes the improved stocking in the older plantations (sites sampled were from 1 to 12 years in age) to the fact that there has been more time on these sites for natural seedlings to establish themselves among the planted trees. He gives two possible explanations for the lower stocking levels on the larger cutblocks. First, large portions of the big cutblocks are out of range of seedfall from the surrounding forest. Second, the large, open spaces created when big blocks are clearcut often have microclimates that are too harsh for the young seedlings.

In comparing the tractor-logged sites with the cable-logged areas, Strothmann points out that the logging and subsequent piling and burning of slash in tractor operations exposes more mineral soil than cable logging and broadcast burning. In describing the influence of elevation on stocking success, he says that higher elevation sites have a shorter period of time in which planting can be done successfully, and that gopher activity is more common at higher elevations.

Further results are in the report, which is available from the Publications Section, Pacific Southwest Station.

Taking a look at the pinyon-juniper woodlands

The pinyon-juniper woodlands have historically provided forage for livestock and wildlife, fenceposts, pine nuts, Christmas trees, firewood, charcoal, mine props, and railroad ties. In addition, these lands are increasingly valued for their watershed, esthetic, and recreational values.

A cooperative research program designed to gain a broad synecological perspective of pinyon-juniper woodlands in the Great Basin was initiated in 1972. Participants are the Department of Range Science, Utah State University; Renewable Resources Center, University of Nevada; and the Intermountain Station.

One of the contributions to that perspective is a report recently published by the Intermountain Station. Authors are Paul C. Tueller, professor of range ecology, University of Nevada; C. Dwight Beeson, a former graduate research assistant at the University of Nevada; Robin J. Tausch, research assistant, Department of Range Science, Utah State University; Neil E. West, professor, Department of Range Science, Utah State University; and Kenneth H. Rea, ecologist, Los Alamos Scientific Laboratory, Los Alamos, New Mexico.

Pinyon-Juniper Woodlands of the Great Basin: Distribution, Flora, Vegetal Cover, INT-RP-229-FR21, includes a discussion of previous work and methods used for this study. The report also contains a detailed map showing the distribution of the Great Basin pinyon-juniper woodlands. According to the authors, the map is the most detailed and field-verified of any available for the pinyon-juniper vegetation type.

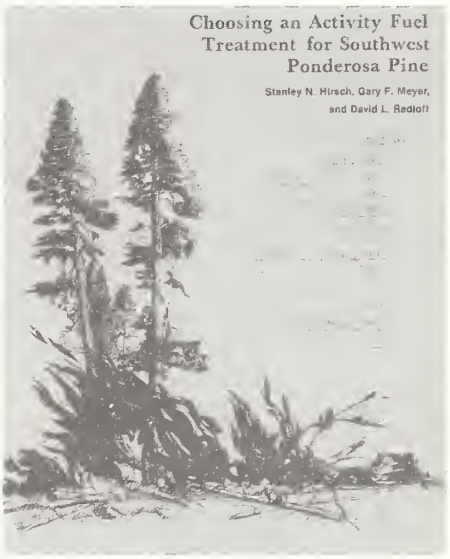
Copies of the report are available from the Intermountain Station.

A case of clearcut damage

Clearcutting timber was the management activity most responsible for increasing the number and frequency of soil mass movements on a Ranger District in western Oregon after a winter storm in 1975. A field inventory showed that clearcutting, without roads, was responsible for more than three-fourths of the slope failures and two-thirds of the volume of debris.

In the past, road-building has been identified as the management activity having the most damaging environmental impacts on forests in unstable terrain. One apparent reason that roads on this District had less impact than clearcuts following this particular storm is that the District has made special efforts in recent years to improve the location, design, and construction of roads and to keep drainages and culverts functioning during storms.

Details are reported in *Mass Movement Response to Forest Management in the Central Oregon Coast Ranges*, by Stuart Gresswell, David Heller, and Douglas N. Swanston, Resource Bulletin PNW-84. Copies are available from the Pacific Northwest Station.



Evaluating fuel treatments

The skyrocketing cost of wildfire-related activities is making wildland fuel management decisions increasingly important. Accomplishing land management objectives may depend on treating large areas of fuels using such tested treatments as prescribed fire or manual and mechanical means to reduce fuel loading.

A general approach for evaluating fuel treatments was recently developed by researchers at the Rocky Mountain Station and tested in the Southwest ponderosa pine forest type. The test was on the Coconino National Forest in central Arizona.

Results of this study are offered in a new report *Choosing an Acitivity Fuel Treatment for Southwest Ponderosa Pine,* General Technical Report RM-67-FR21, by Stanley N. Hirsch, Gary F. Meyer, and David L. Radloff.

The report describes the methods and steps used to reach a final preferred fuel treatment decision. Copies are available from the Rocky Mountain Station.

A new approach to environmental impacts

An innovative approach to evaluating environmental impacts, which involves the help of resource specialists, can be used by analysts and land-use planners. The approach was developed by two economists at the Pacific Northwest Station whose assignment was to examine two of many social consequences that might result from changes in the Forest Service policy of scheduling timber harvests on a non-declining, even-flow basis. They examined the long- and short-range effects of six harvest scheduling alternatives, at both low and high levels of investment, on forest ecosystems and non-timber uses of the forest. They evaluated impacts on water, soils, fish and wildlife, air, vegetation, forage production for livestock, dispersed and developed recreation, opportunities to view natural forests and wildlife, deer and elk populations, and uses of water.

In a recent report, the economists explain the methods they developed and show how the process worked on one National Forest. Copies of *Identifying and Evaluating Environment Impacts Associated with Timber Harvest Scheduling Policies* by Robert M. Randall and Robert W. Sassaman, General Technical Report PNW-81, are available from the Pacific Northwest Station.

Tool estimates fuel moisture

A model to estimate the moisture of live fuels is available for the 1978 National Fire Danger Rating System (NFDRS). As discussed in a paper by Robert E. Burgan of the Intermountain Station's Northern Forest Fire Laboratory, the model replaces the herbaceous vegetation transects used in the 1972 NFDRS. The new model provides a broad scale approximation of the moisture content of living herbaceous plants and the leaves and twigs of woody shrubs.

Applying the concept, the user can "tune" the model to produce seasonal, live woody and herbaceous moisture profiles that are reasonable for a selected area.

In *Estimating Live Fuel Moisture for the 1978 National Fire Danger Rating System*, INT-RP-226-FR21, Burgan also discusses conditions that must be met to successfully apply the model.

Copies of the publication are available from the Intermountain Station.

Mitigation symposium proceedings out

Fish and wildlife conservationists have long been concerned over the loss of habitat as a result of changing land and water use, particularly those changes associated with federal development projects.

This past July, fish and wildlife specialists from across the country met at Colorado State University to discuss the "loss of habitat" problem and ways to help solve it.

The objectives of the week-long meeting, titled "The Mitigation Symposium: A National Workshop on Mitigating Losses of Fish and Wildlife Habitats", were to review the magnitude and seriousness of habitat losses and the extent to which these losses are being and have been mitigated, and to develop strategies and practical recommendations for minimizing losses and achieving more effective mitigation.

Over 100 papers were presented in sessions on coastal zone and inland wetlands, water developments, transportation systems, power projects, evaluating impacts, economic considerations, and legal and political concerns.

Copies of the 700 page proceedings, General Technical Report RM-65-FR21, are available from the Rocky Mountain Station.

Air pollution symposium planned

An international symposium on the effects of air pollution on Mediterranean and temperate forest ecosystems will be held June 22-28, 1980, in Riverside, California. The conference is designed for foresters, scientists, and administrators. Conference topics will include the effects of air pollution on tree growth, on species composition of forest stands, and on forest wildlife, insect pests, and tree diseases. The program will also cover the effects of acid precipitation on forests, and emission of nitrogen oxides, hydrocarbons, and other natural pollutants from forests. A major focus of the conference will be techniques for integrating data from diverse, highly specialized studies into ecosystem-level analyses.

Further information is available from the conference chairman, Dr. Paul R. Miller, at the Pacific Southwest Forest and Range Experiment Station, 4955 Canyon Crest Drive, Riverside, California 92507. Preregistration is advised.

Bird census symposium scheduled

"Estimating Populations of Terrestrial Birds" will be the subject of a symposium scheduled for October 27-30, 1980, at the Asilomar Conference Grounds near Monterey, California. According to conference co-chairmen C.J. Ralph of the Pacific Southwest Station and J. Michael Scott of the U.S. Fish and Wildlife Service, the conference "is designed for wildlife biologists, statisticians, and others who are interested in increasing the reliability of censuses and sampling techniques." Topics to be discussed will include methods for estimating populations, designs for censusing and sampling, techniques for collecting and analyzing data, approaches to correcting biases and other sources of error, and solutions for the special problems associated with estimating certain groups of bird species, including nocturnal species, colonial species, and others.

For further information, write to Dr. Ralph or Dr. Scott in care of the Bird Census Symposium, P.O. Box 43, Hawaii Volcanoes National Park, Hawaii 96718.

There will be good reading in the May issue. We'll examine habitat management for the grizzly bear in the Yellowstone ecosystem; look at ways to rehabilitate a forest following a large wildfire; cover management of wildlife habitat in the Western Sierra Nevada; and take a look at research involving two rare trout in the Southwest.

If you know of someone who would be interested in this publication, he or she can be added to the mailing list by filling out the coupon below and mailing it to us.

Please add my name to the mailing list for *Forestry Research West.*

_____

_____

_____

Mail to: *Forestry Research West*
U.S. Department of Agriculture
Forest Service
240 West Prospect Street
Fort Collins, Colorado 80526

☆U.S. GOVERNMENT PRINTING OFFICE:1980—682-625/209

Forestry Research West

U.S. Department of Agriculture
Forest Service
240 West Prospect Street
Fort Collins, Colorado 80526

Official Business
Penalty for Private Use, $300.

BULK RATE
POSTAGE & FEES PAID
USDA · FS
Permit No. G·40